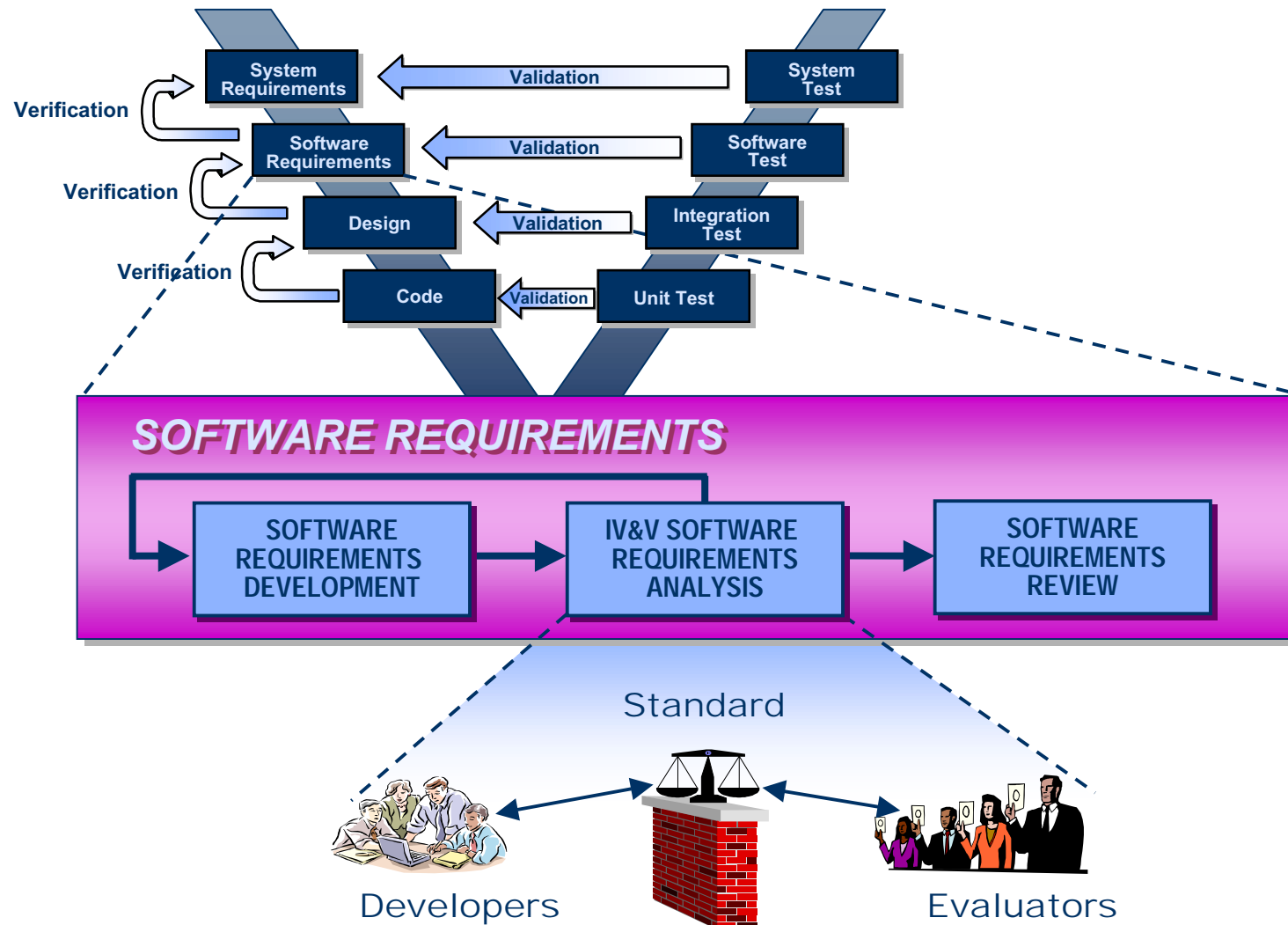




INDEPENDENT INTEGRATED VERIFICATION AND VALIDATION (I²V²)

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INDEPENDENT VERIFICATION and VALIDATION (IV&V)



IV&V BENEFITS AND POTENTIAL PROBLEMS

BENEFITS

- § Early detection of defects that might otherwise remain undetected until later in the lifecycle (reduced cost and schedule)
- § Independence (technical point of view, toolset, process) allows identification of defects that could be overlooked by development personnel
- § Ensures that the delivered software will meet each baselined software requirement
- § Provides the Customer with increased visibility into software status and quality
- § Reduced maintenance cost
- § Can serve to fill the many communication holes that result from performance-based acquisition

POTENTIAL PROBLEMS

- § Overemphasis on independence can result in non-productive, adversarial relationship between the IV&V contractor and the Development contractor
- § IV&V analyses can be out of sync with Developer internal reviews creating a separate review and rework process that can impact the development schedule
- § Not consistent with acquisition reform efforts
- § IV&V efforts traditionally not integrated with process improvement goals
- § View of the standard is often different on opposite sides of the wall

INDEPENDENT INTEGRATED VERIFICATION and VALIDATION (I²V²)

w I²V² attempts to address the potential problems of IV&V without negatively impacting its benefits

w Goals of I²V²

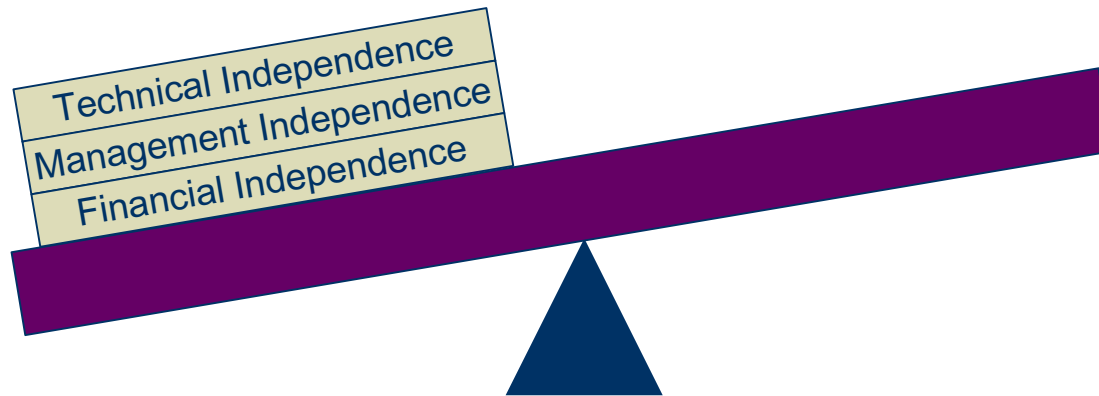
- n Reduce/eliminate the schedule impact of IV&V
- n Provide for collaboration between the IV&V Team and the Developer
- n Integrate IV&V directly into the Developer's process and process improvement program



- n Close coupling of production and inspection, reduce defect leakage
- n Eliminate adversarial relationship between the IV&V team and the Developer
- n Eliminate hidden IV&V financial conflicts

INDEPENDENCE IN AN INTEGRATED ENVIRONMENT

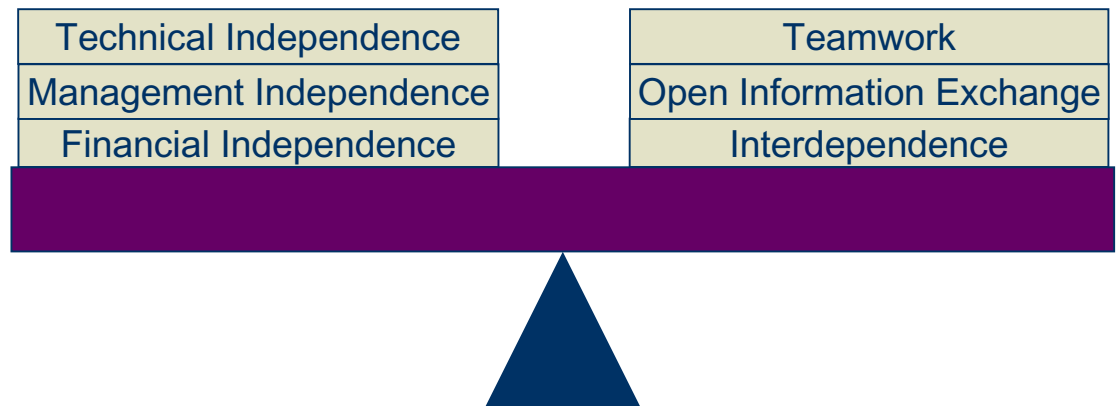
Traditional IV&V



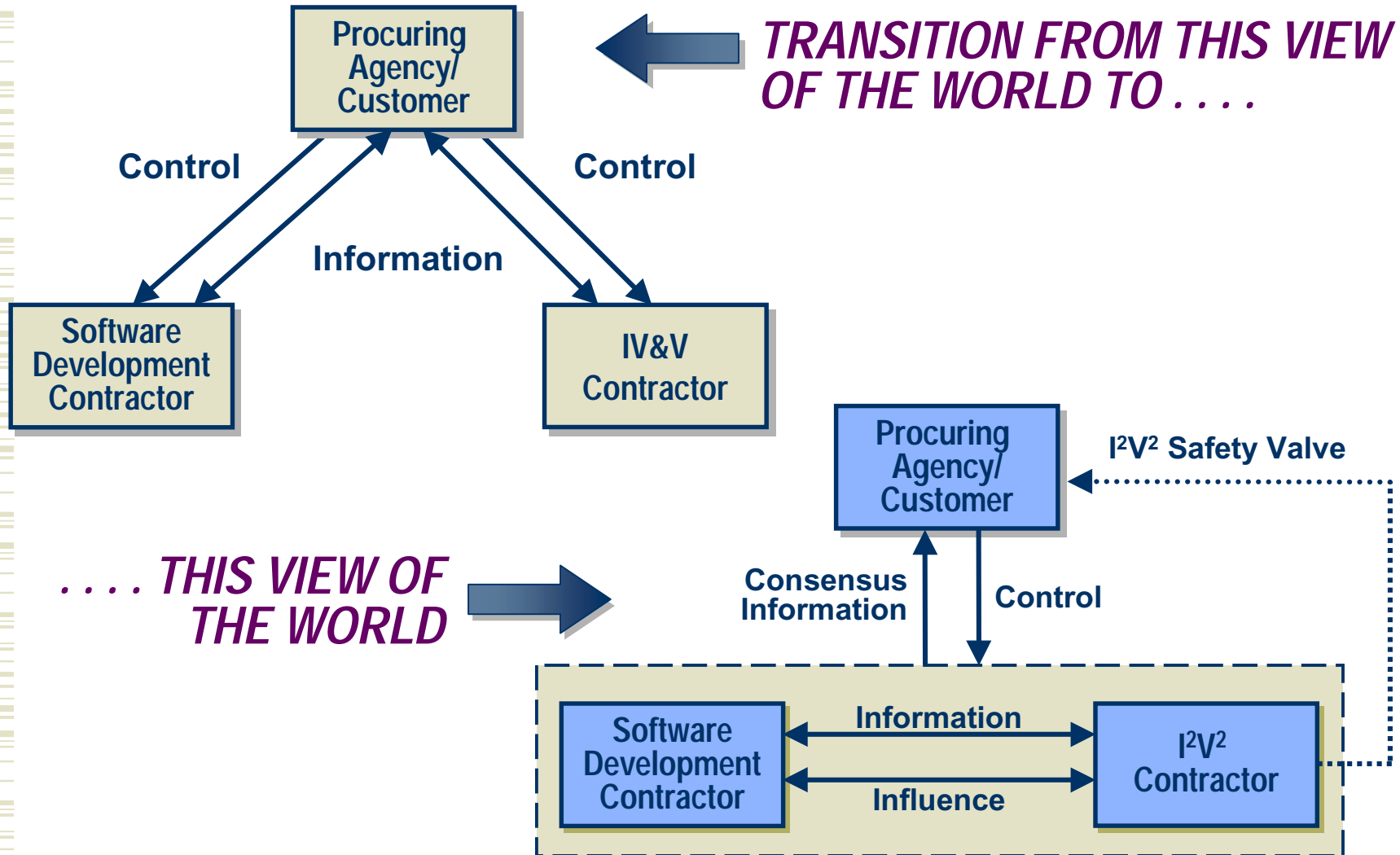
Traditional IV&V places ultimate importance on independence. Even a perception that independence is not maintained is frowned on and viewed as a weakness.

I²V²

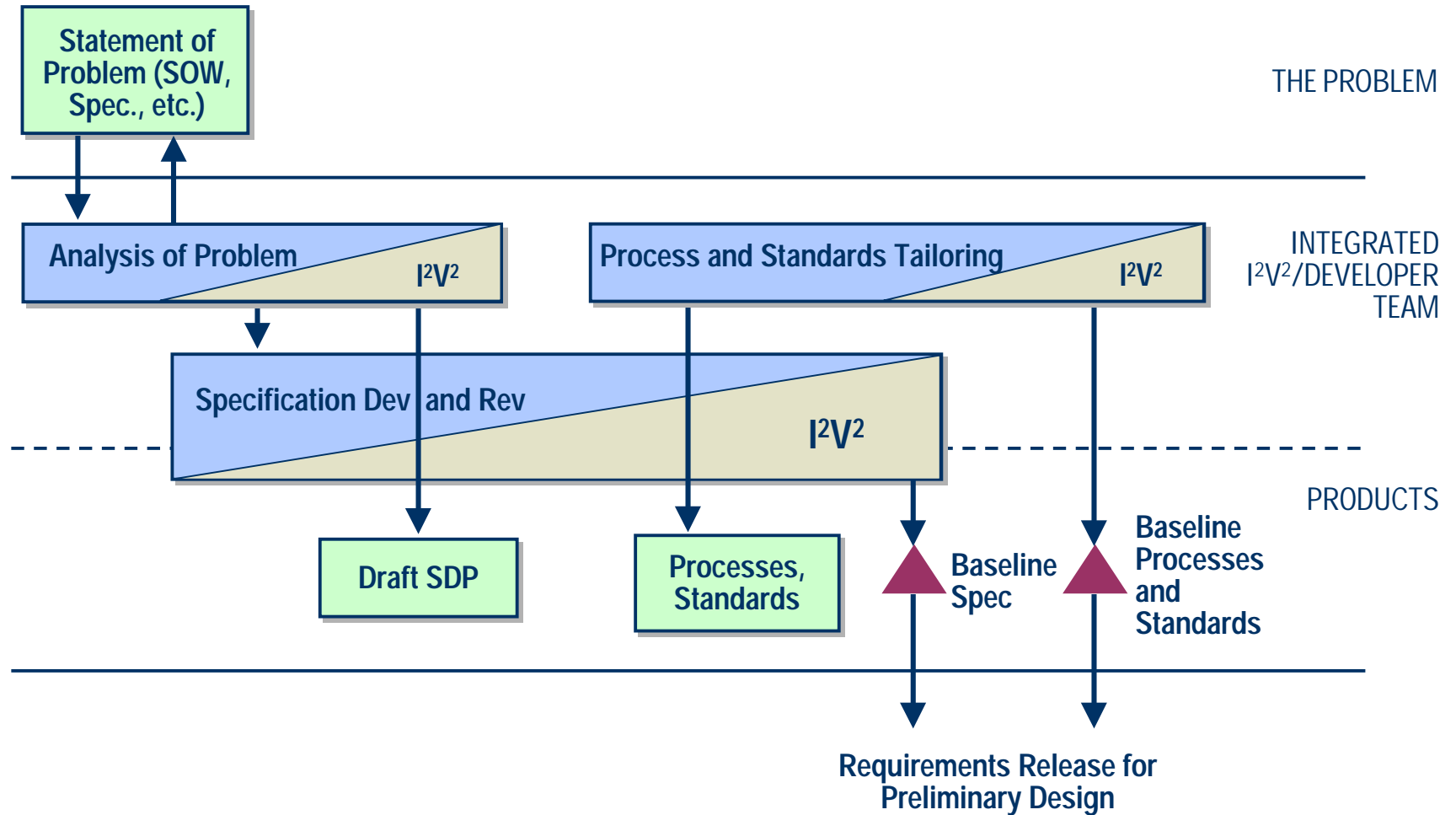
I²V² takes a balanced approach to independence. It is willing to accept a perceived reduction in technical independence in order to gain previously discussed benefits such as open information exchange, interdependence, and teamwork.



OPEN COMMUNICATION AND INFORMATION EXCHANGE



THE INTEGRATED TEAM PROCESS



OTHER KEY PROPERTIES OF I²V²

- w Common goals and common definition of success (interdependence)
- w Integration of I²V² effort into the Developer's process
- w Participation in internal Developer reviews
- w Integration of I²V² effort into Developer's process improvement program
- w Striving for a common I²V² and Developer assessment of risks and status to Customer

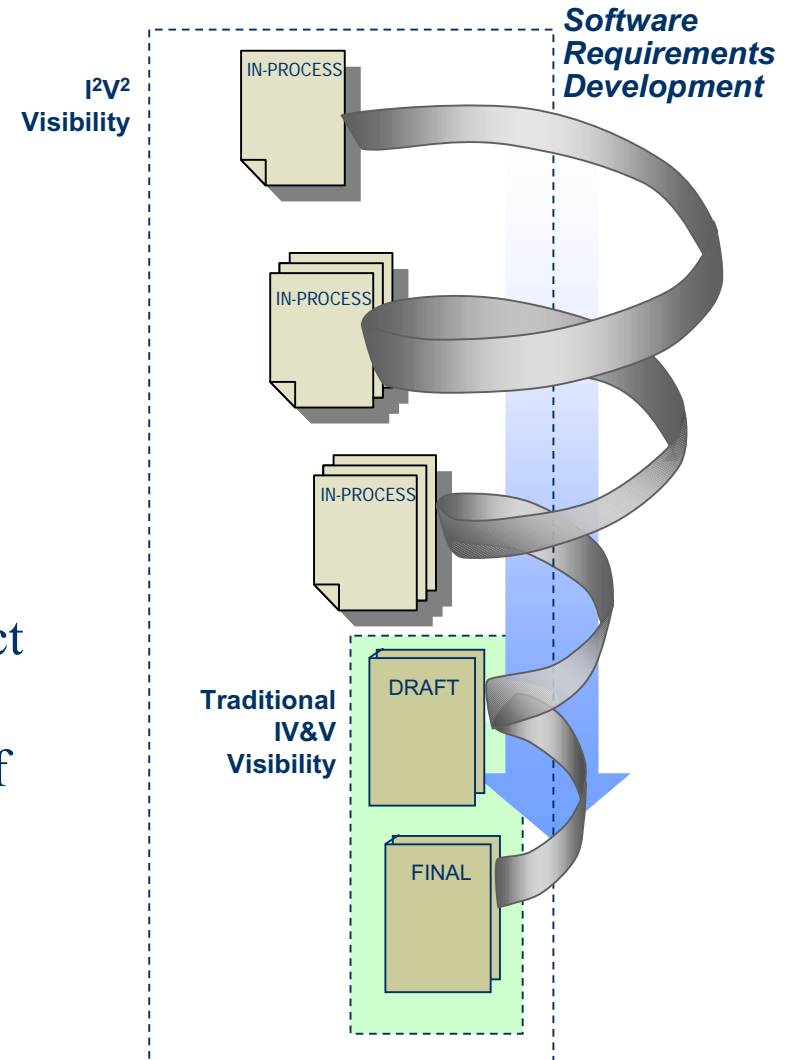
INDEPENDENCE → INTERDEPENDENCE

- w With Traditional IV&V it is possible for the IV&V Team to succeed while a program fails
 - n The IV&V Team can succeed by identifying a large number of Developer problems (“I told you so”)
 - n The IV&V Team has no accountability for system failure
 - n This is the basis for many adversarial relationships between IV&V Teams and Developers
- w I²V² is built on an interdependent relationship between the I²V² Team and the Developer
 - n With I²V², both the Developer and the I²V² Team will either succeed or fail together (achieve jointly defined objectives)
 - n If the Developer is failing, it is up to the I²V² Team to cooperatively develop approaches for resolving the associated problems
 - n In certain circumstances, the I²V² Team may assume responsibility for jointly agreed to tasks

INTEGRATION OF I²V² INTO THE DEVELOPMENT PROCESS

WHY INTEGRATE?

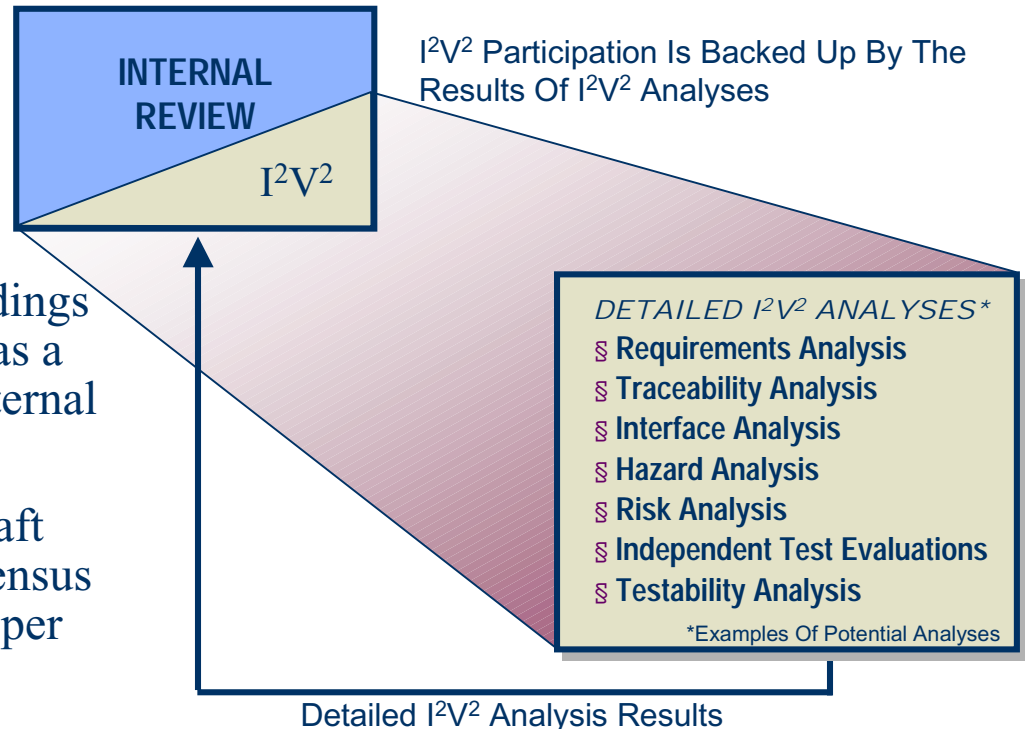
- w Recognition that development is an iterative process that starts well before the release of a draft document (planning)
- w The quality of a product is often determined by choices that are made long before the first artifact is produced
- w Take advantage of multiple opportunities for I²V² analysis and feedback prior to release of draft product
- w Supports a goal of releasing a draft document that represents a consensus of the I²V² Team and the Developer
- w Concurrence on methods of evaluation and the standards of “goodness”



PARTICIPATION IN INTERNAL REVIEWS

WHY PARTICIPATE?

- § Reduce schedule by eliminating a separate I²V² review and rework process
- § Earlier incorporation of I²V² findings since they will be dispositioned as a natural part of the process for internal reviews
- § Supports a goal of releasing a draft document that represents a consensus of the I²V² Team and the Developer



ADDED BENEFITS

- At times, Developers have too many demands on their time to adequately prepare for Reviews/Walkthroughs/Inspections. They have to support multiple IPTs, Peer Reviews, and Walkthroughs, etc. while trying to find time to perform their own technical work
- I²V² analyses serve to supplement peer review comments providing developers with better feedback on their incremental products
- I²V² can also serve as a communications layer between program IPTs

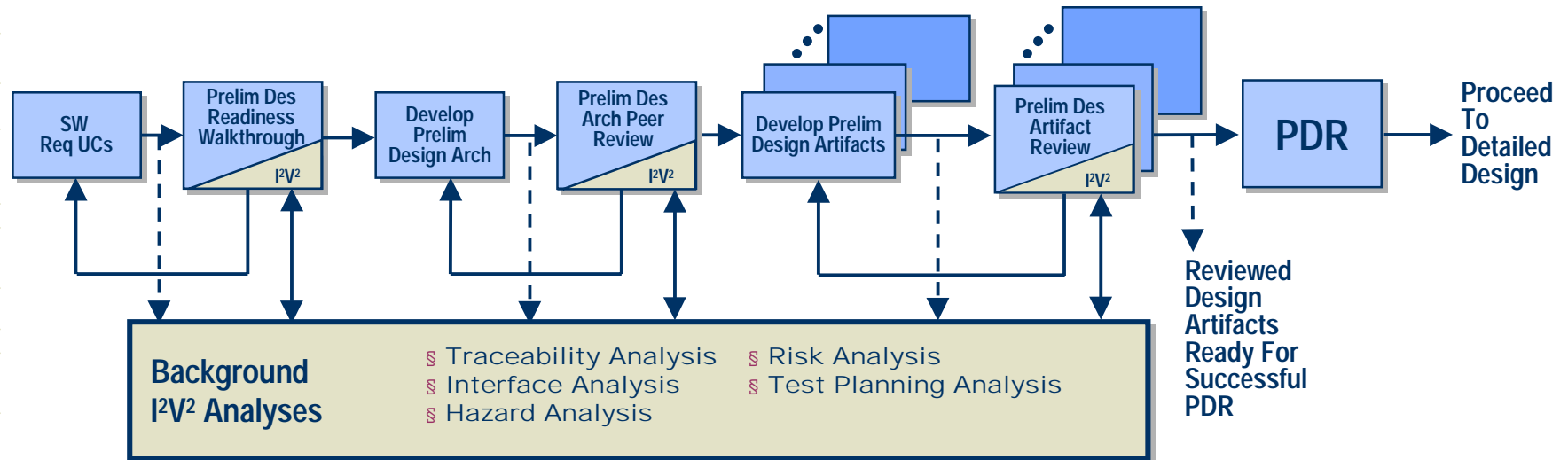
PROCESS IMPROVEMENT

- w Traditional IV&V is focused on the detection and documentation of defects
- w I²V² recognizes that modern process definition and control techniques are critical to developing high quality software
- w I²V² can participate with a software engineering process group to provide root cause analysis for common defect types
- w Root cause analysis can be used to modify software development processes to prevent defects from being created in the first place

PROVIDING THE CUSTOMER WITH THE DATA THEY NEED

- w With traditional IV&V, all information flowed through the Customer so lack of data was never an issue; however, often the data was not at a useful level and/or was inconsistent (Developer view versus IV&V view)
- w I²V² focuses on providing the Customer with data they need to manage the program without useless detail
 - n Direct data flow between the I²V² Team and Developer eliminates information overload for the Customer
 - n Detailed information generated during I²V² and development efforts is abstracted to provide the Customer with status assessments for key software components and key software functional areas; Green, Yellow, Red Stoplight charts provide an excellent mechanism for such assessments
 - n Action plans are provided to address items with Yellow or Red assessments
 - n Whenever possible, the status assessments are presented as a consensus position of the I²V² Team and the Developer eliminating inconsistent data inputs to the Customer that forces them to arbitrate between two conflicting views

I²V² - PUTTING IT ALL TOGETHER (PRELIMINARY DESIGN EXAMPLE)



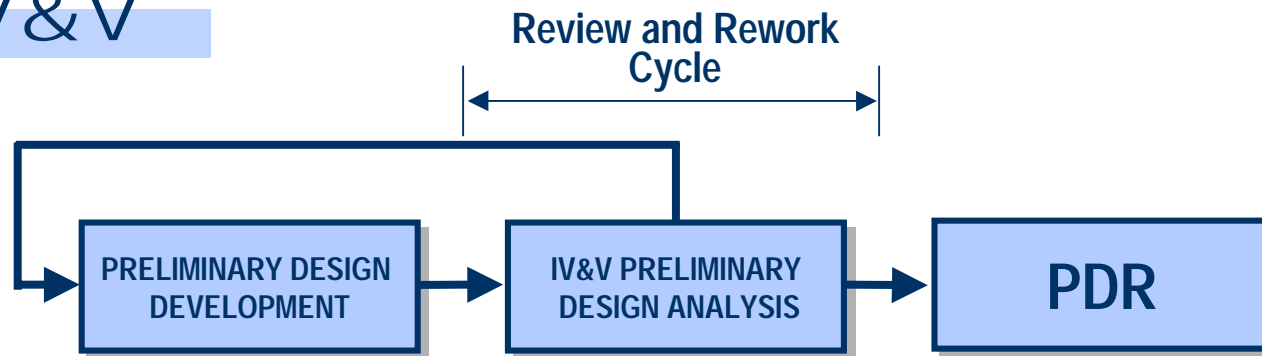
Independent Integrated Verification and Validation (I²V²) is the application of an IV&V process integrated within the software development process. The I²V² team actively participates in all aspects of the software process in order to detect and resolve errors before they are captured in deliverable products.

COMPARING I²V² TO IV&V (PRELIMINARY DESIGN EXAMPLE)

I²V²



IV&V





SOME IMPLICATIONS OF I^2V^2

w Rapid I^2V^2 analyses

w Challenges and limitations

RAPID I²V² ANALYSES

- w Background I²V² analyses can provide incremental analysis results to support quick response internal reviews
- w Focus quick response analyses to reduce analysis time; focus based on:
 - n Anticipated problem areas based on past experience
 - n Known problem areas based on earlier analyses
 - n Risk Analyses
- w Use tools to automate and speed up analyses
 - n Developer Tool Set
 - n V&V Tool Set
 - n Microsoft Tool Set (otherwise known as Office)



CHALLENGES AND LIMITATIONS

- w Must get “buy-in” from all parties (Developer, Customer, I²V² Analysts)
- w Must have trust and honor in all parties
- w Must clearly define roles and responsibilities of the I²V² Team versus that of the Developers to avoid conflicts
- w Success has to be defined as a win-win-win proposition
- w Strong interpersonal skills are a must for all parties
- w Must have highly skilled I²V² analysts
 - n Developer will never enter into this close relationship with technically inferior analysts
- w I²V² analysts may need to co-locate at Developer site
- w Analysis can only find so many problems
 - n I²V² analysts must realize that they are products of their past experience

I²V² EXPERIENCE



- w I²V² Teams successfully participated in two recent Army software development programs
- w I²V² supported Developer process improvement initiatives transitioning from CMM Level 1 to Level 4 over a seven year period
- w Met all key schedule dates under program control
- w Successful IOT&E and multi-year production awards
- w Cooperative Research and Development Agreement (CRDA)
- w Nominated to Crosstalk as one of Government's top five software projects
- w I²V² Team provided a built-in surge capability for the program

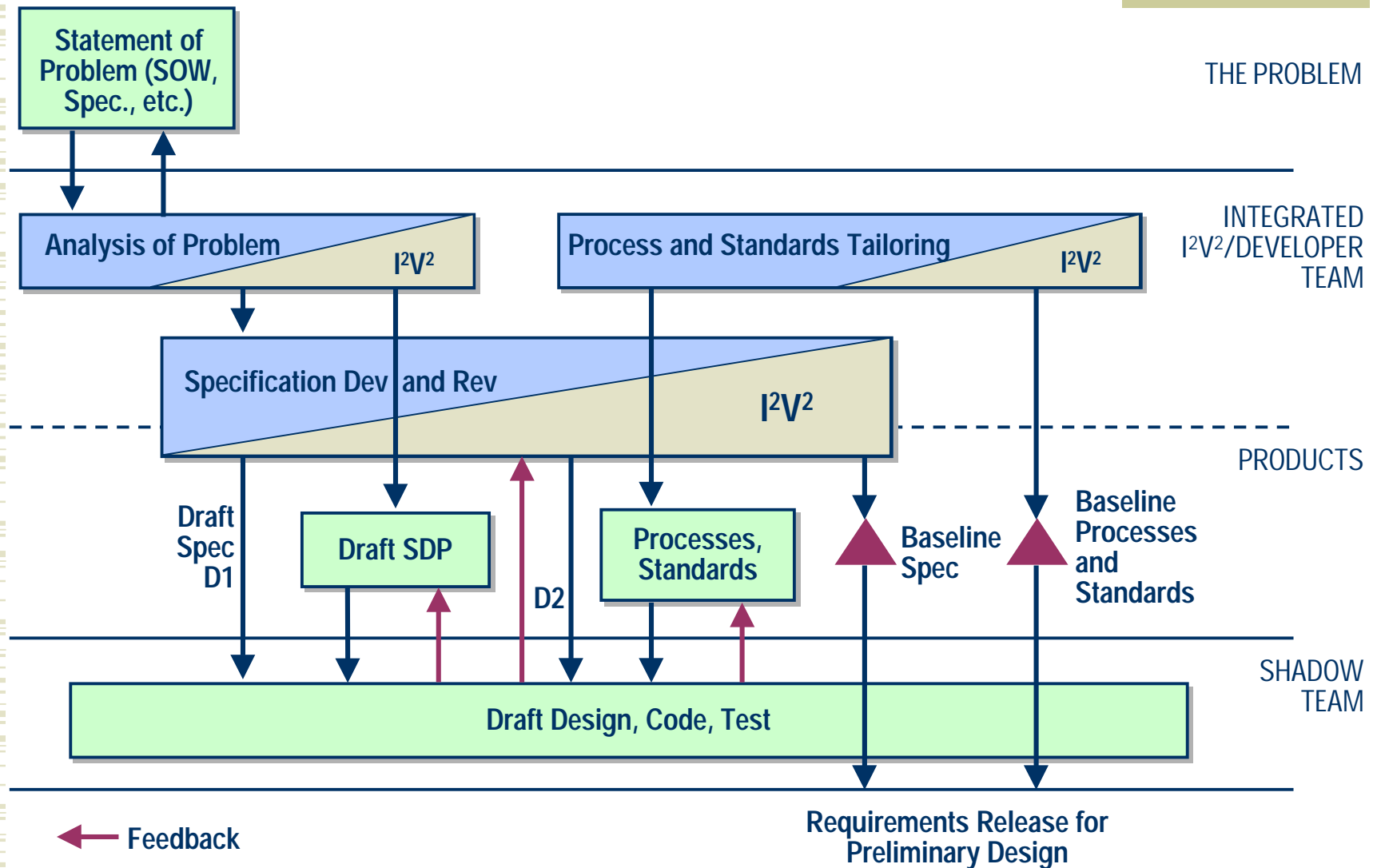
I²V² - A PROPOSED EXTENSION

- w IV&V often uses artifact analysis to predict downstream problems (e.g., if requirement X isn't traced to the design, it won't be implemented)
 - n Analysis is heavily based on past program experience
 - n Difficult to recruit qualified, experienced staff to do analysis
 - n Ignores data or knowledge not in IV&V documentation domain
- w I²V² could be supplemented by a “shadow” development team working 1-2 process phases ahead of main development
 - n Personnel from Developer and I²V² team members
 - n Verify the analytical “predictions” correctness
 - n Tune the analysis methods by flowing findings back to main development team
 - n Detect problems not found by analysis (e.g., unplanned test tools)
 - n Refine/validate downstream process and standards (e.g., unit testing)

I²V² - A PROPOSED EXTENSION (Continued)

- w Demonstration/Prototype Products
 - n Most programs rely heavily on these for customer assessment
 - n Often done with totally different processes
 - n Having I²V² members on these teams could greatly benefit program
 - 1 Potentially allow for releasable products for certain uses
 - 1 Tune the I²V² analysis to focus on actual versus theoretical problems
 - 1 Recruit and retain better I²V² staff
 - 1 Allow for more research on cooperative rapid prototyping
- w Early detection of integration problems
- w Validation of artifact quality and usefulness
- w Risk reduction
- w Faster maturation of software

THE INTEGRATED TEAM PROCESS (WITH SHADOW TEAM)



CONCLUSIONS

- w IV&V is an effective/proven methodology
- w Where workable, I²V² provides a refinement to the IV&V process that addresses aspects of IV&V that have presented problems in the past
- w I²V² meets much of the definition of independence without the barrier to communication of “the wall”
- w The right team members and managers are needed
- w Offers an alternative that addresses declining use of rigid standards

I²V² - WHERE DO WE GO FROM HERE?

- w Article is currently in work to provide a more detailed discussion of the key elements of I²V²
- w Written I²V² procedures to be generated in parallel with application on future programs
- w Proposing the addition of I²V² as a named V&V form in the next update of IEEE STD 1012-1998 (nothing in the current version of the standard precludes I²V²)
- w Future project to develop a tutorial if there is sufficient interest in the I²V² concept

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